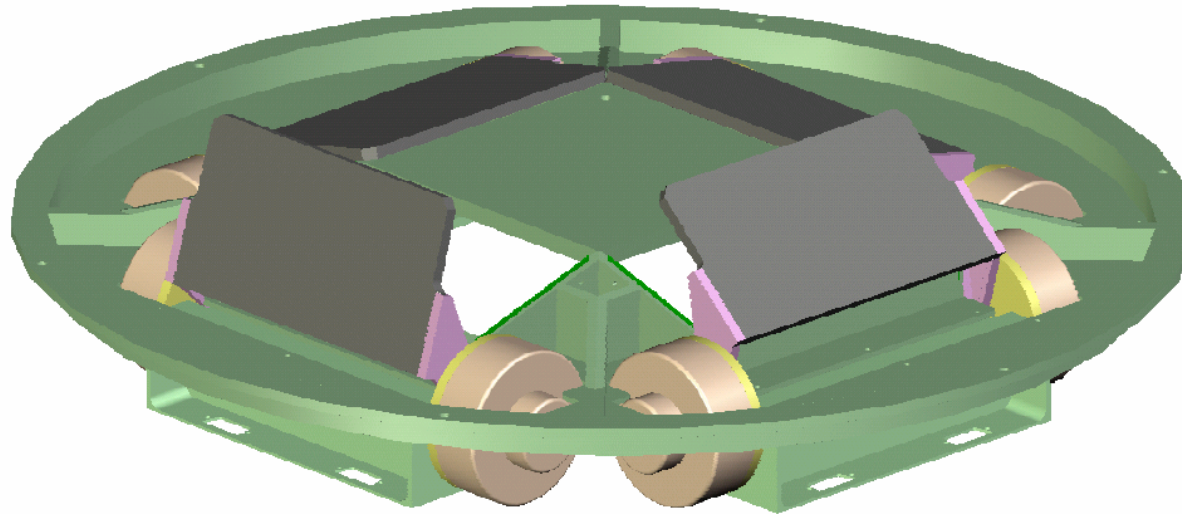## SNAP-TECH-07-003: Cassegrain Shutters
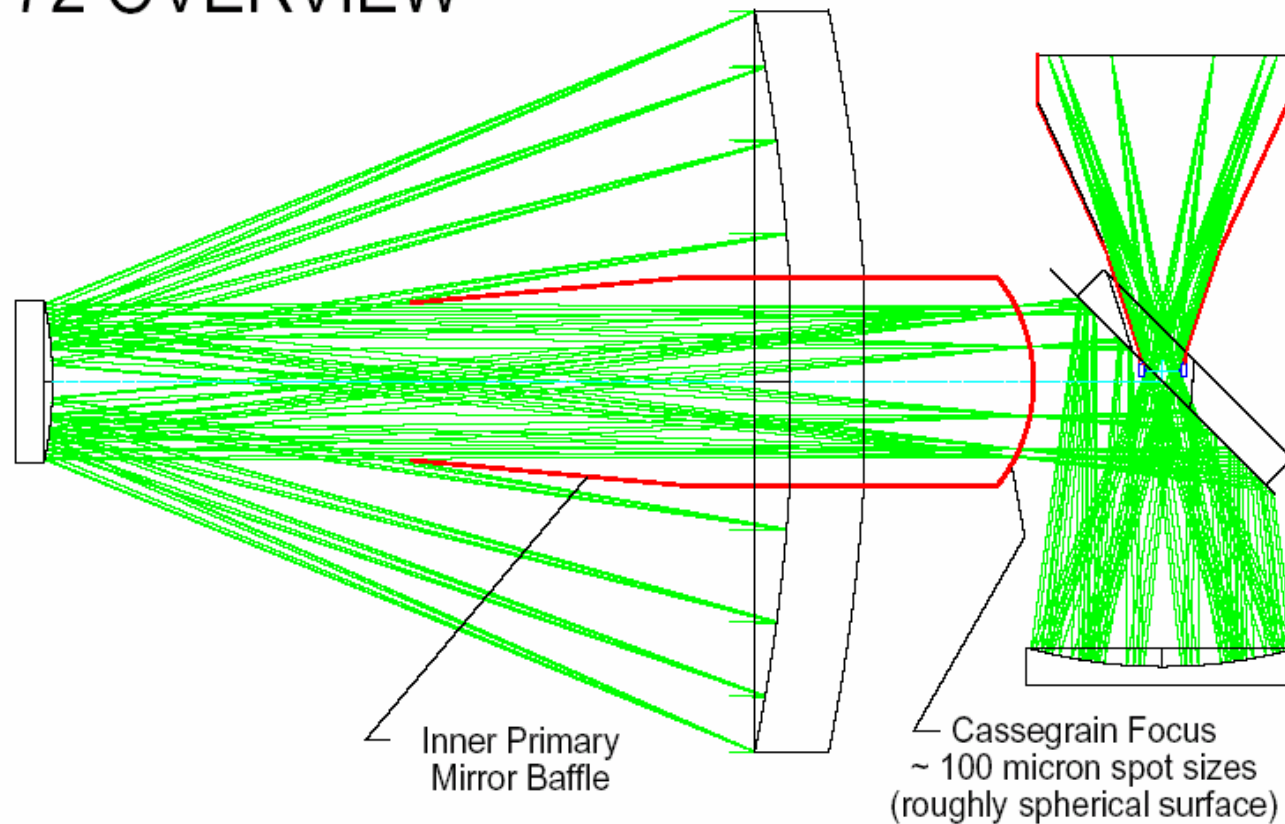

0.61m ϕ Ribbed Aluminum Cassegrain Mask

- ➤ "Postcard Size" ~ 20 gram Aluminum Sandwich Shutters
- ➤ Redundant 60° LAT Motor Drives with Resolvers for Feedback
- ➤ FPGA based control for Repeatable Exposures & Smooth Motion
- ➤ ACS Guider Ports are **NOT** Shuttered
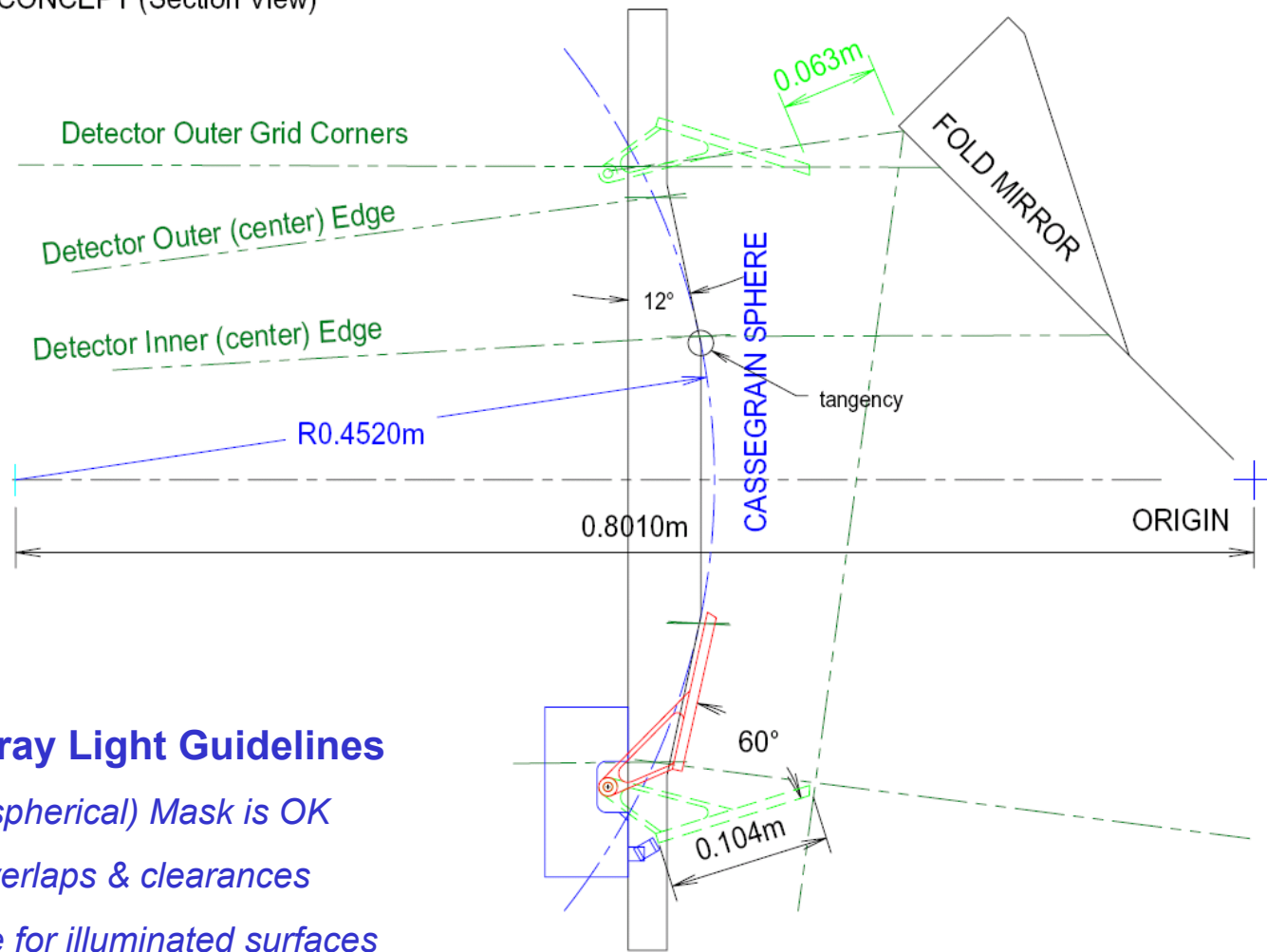
filename: SNAP shutters

TMA-72 OVERVIEW

Inner Primary Mirror Baffle

Cassegrain Focus ~ 100 micron spot sizes (roughly spherical surface)

Inner Baffle and Cassegrain Mask Should Provide a Stray Light Trap

filename: SNAP shutters

SNAP - Cassegrain Mask & Shutters

TMA-72 CASSEGRAIN MASK & SHUTTER
CONCEPT (Section View)

0.063m

Detector Outer Grid Corners

FOLD MIRROR

Detector Outer (center) Edge

12°

CASSEGRAIN SPHERE

Detector Inner (center) Edge

tangency

R0.4520m

0.8010m

ORIGIN

M.J.S. Stray Light Guidelines

➤ *Flat (or spherical) Mask is OK*

➤ *3 mm overlaps & clearances*

➤ *-3° slope for illuminated surfaces*

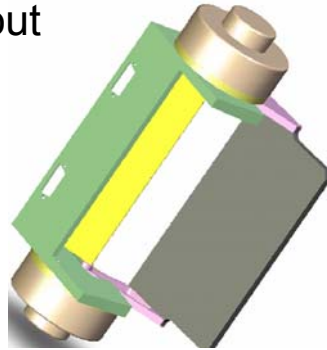60°

0.104m

filename: SNAP shutters

3

SNAP - Cassegrain Mask & Shutters

Mask and Shutter Assembly Detail

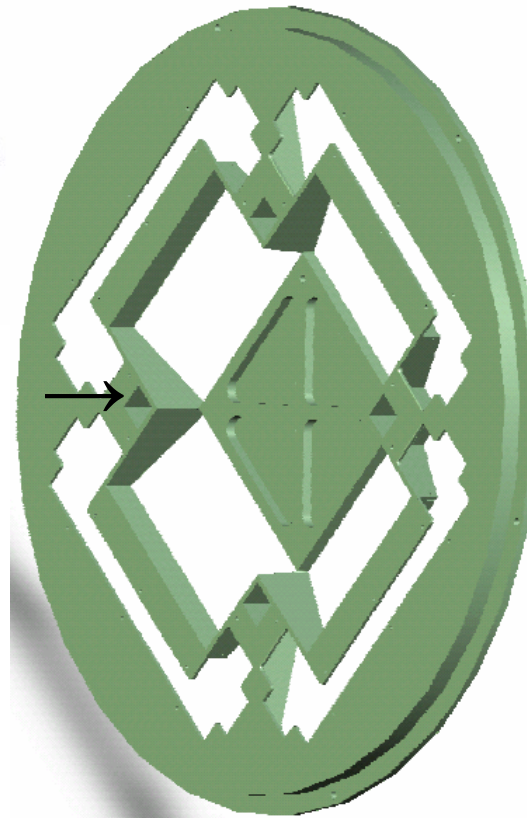### Individual Shutter Sub-Assemblies

➢ Install thru Mask Cutout

Thru the Telescope (T^3) Guider ports
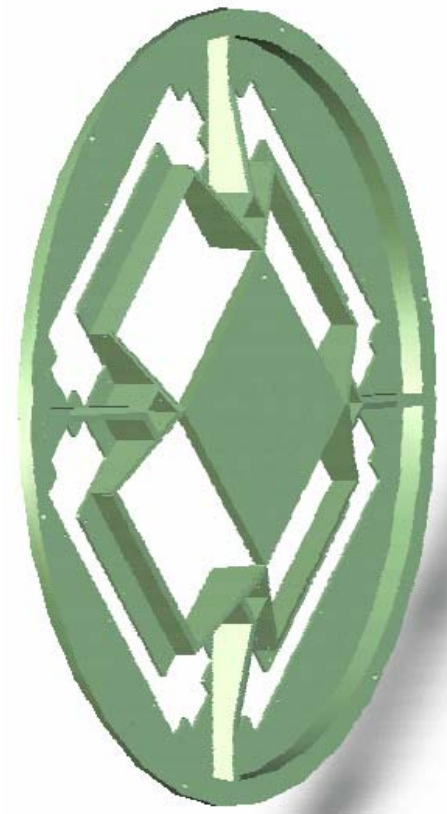
Shutter Base
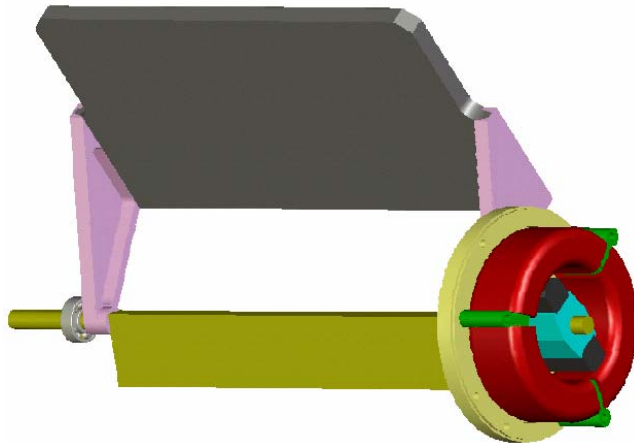
➢ Stiffens Mask Cutouts

Mask Top   Mask Bottom

filename: SNAP shutters
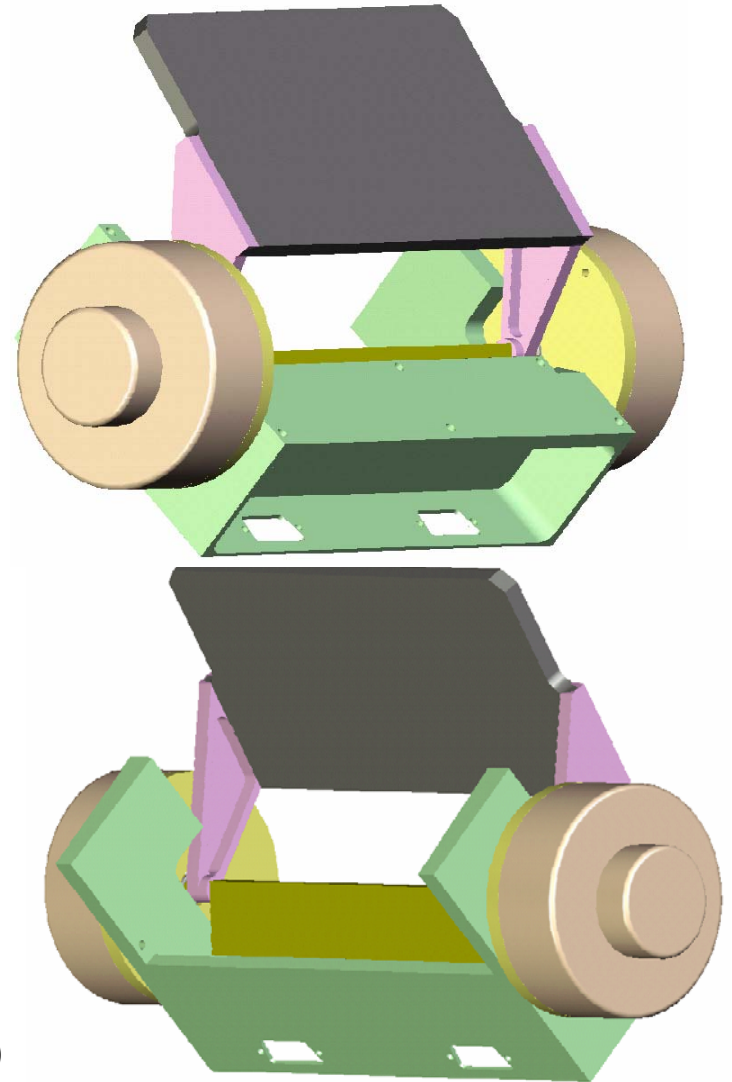
SNAP - Cassegrain Mask & Shutters

Composite of Shutter Assemblies

Shutter Blade & Counterweight Assembly

Limited Angle Torque (LAT) Motor (2)

filename: SNAP shutters

SNAP - Cassegrain Mask & Shutters

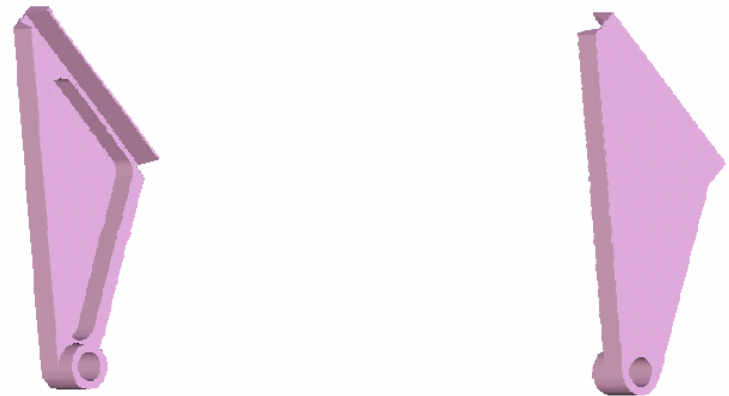## Shutter Blade Assembly Details

Bonded Al Honeycomb Blade

➢ 4 mil Al skins, 1/8" cell - 3.1 pcf Al Core

  ➢ 1/8 – 5056 – 0007 seems the 'good choice'

➢ Honeycomb Core Fill near End Brackets

Machined Al Blade End Brackets

➢ Modest Bonding / Alignment Fixtures needed

Al Shaft and Counterbalance

➢ Roll Pins in End Brackets after Balancing

➢ Braycote 602 Lubricated M6 Ball Bearings

filename: SNAP shutters

SNAP - Cassegrain Mask & Shutters

Bumper Stops are needed for FPGA Malfunctions Only *(28V → ω_f → 32 rad/s)*

➢ Polyurethane Bumper Strips in the Mask for Closing

    ➢ ≈ 3 mm Over Travel Allowed *(First Shutter Light at ~7½ mm)*

        ➢ Shutter Closed Position is ~3½ mm above the Mask

    ➢ Impact Forces are near the Blade's **Center of Percussion**

➢ Leaf Spring Bumpers for the Opening Direction

    ➢ Longer ≈ 10 mm Over Travel Assumed

BLADE PEAK DECELERATION
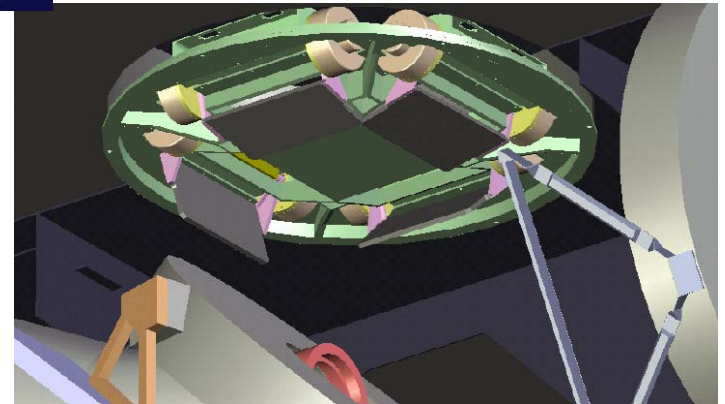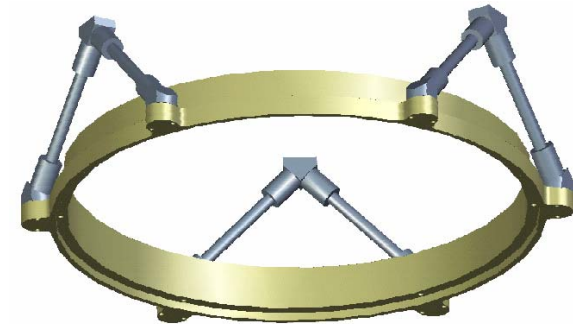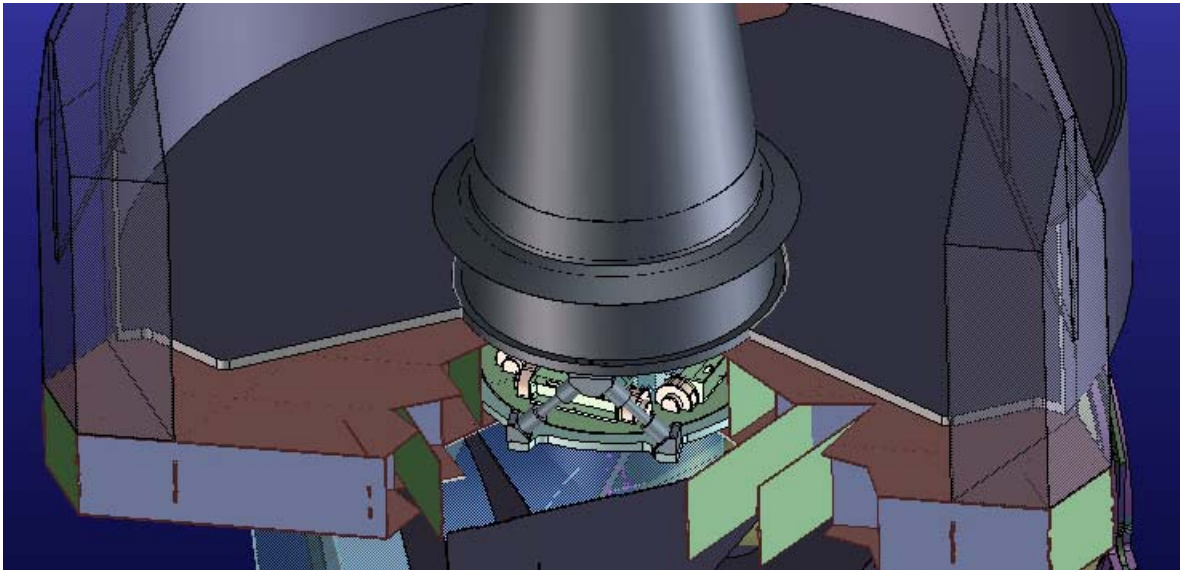(Elastic (F = kX) Bumper Assumed)
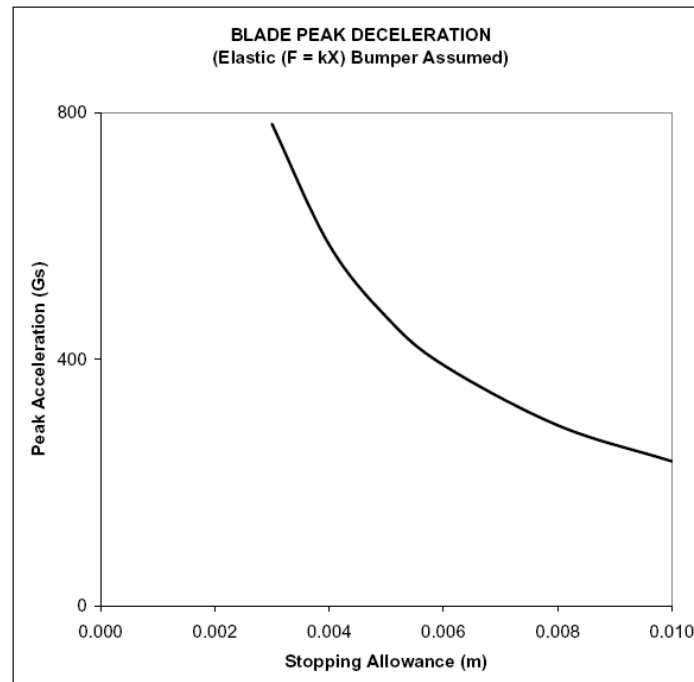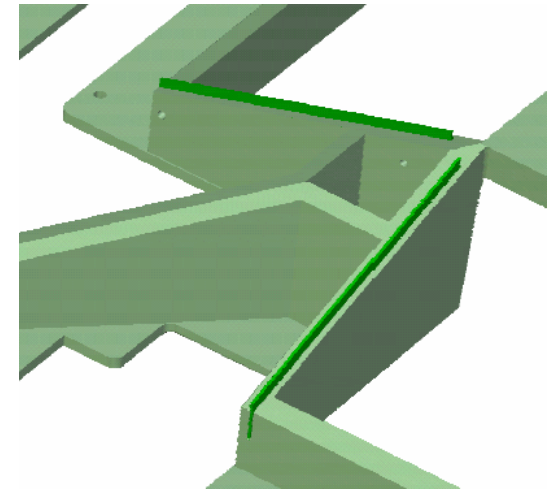
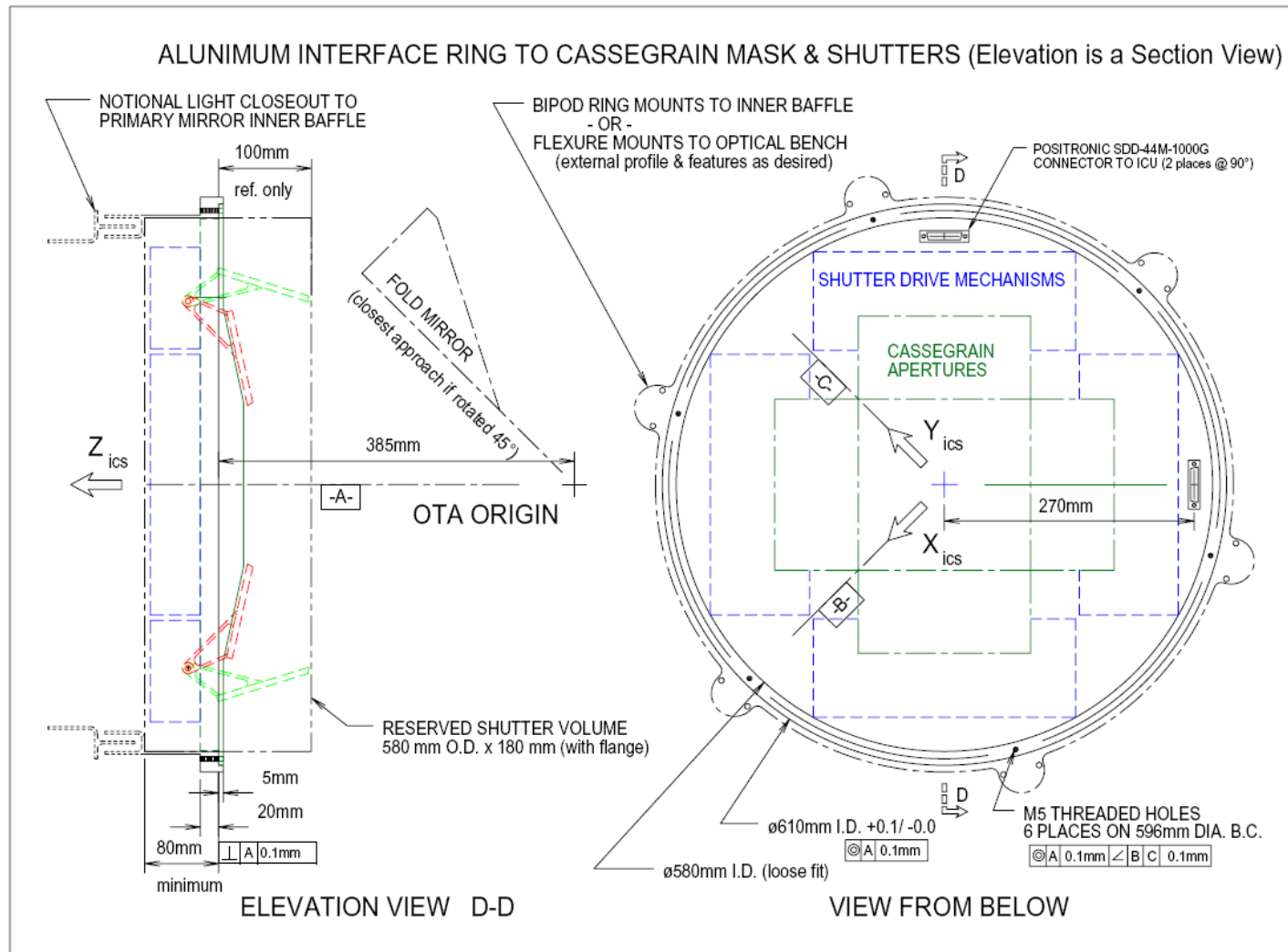# SNAP - Cassegrain Mask & Shutters

Shutter Installation – location is somewhat awkward, but Workable

➤ Shutter Interface Ring on Bipods (or flexures) Installed in OTA Early
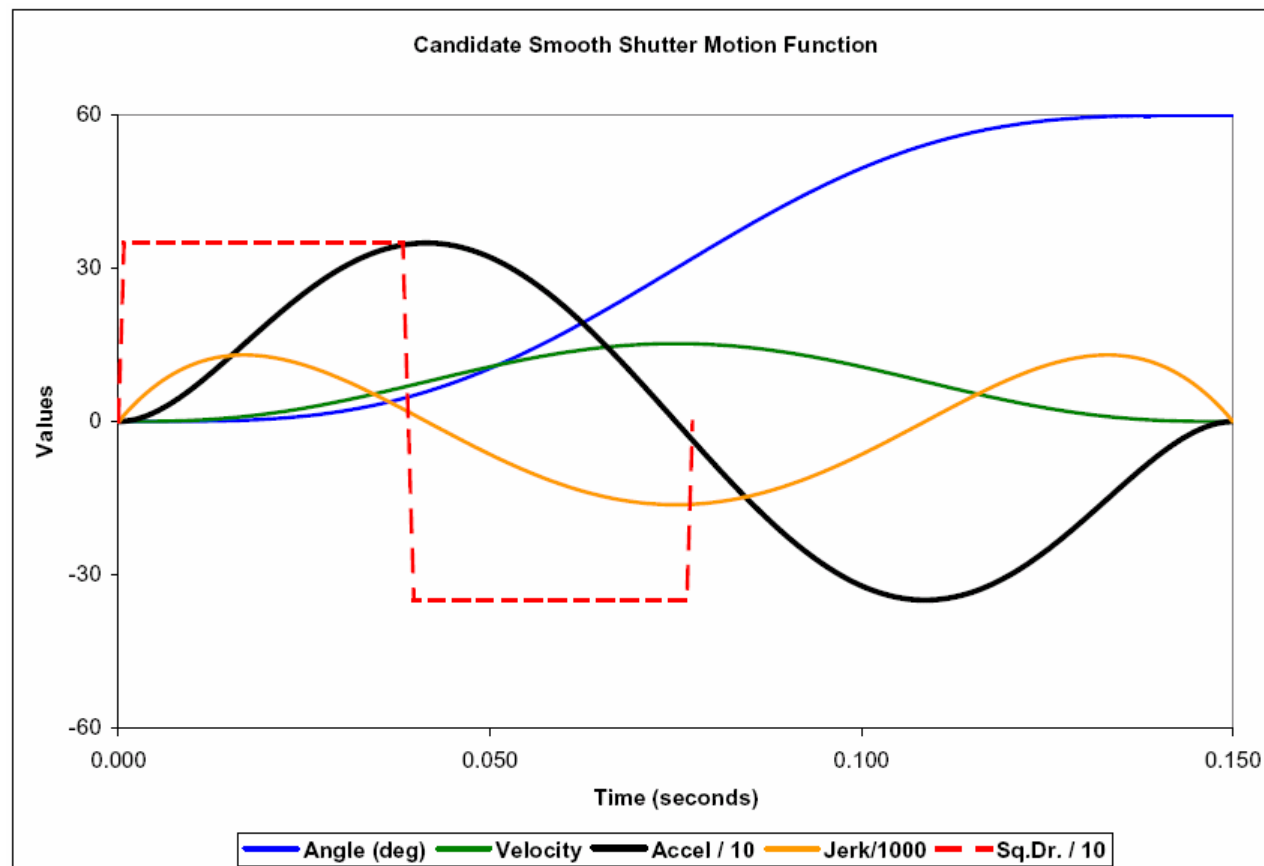
SNAP - Cassegrain Mask & Shutters

ALUNIMUM INTERFACE RING TO CASSEGRAIN MASK & SHUTTERS (Elevation is a Section View)

Telescope ICD

filename: SNAP shutters

Shutter Smooth Motion Profile – FPGA control planned

➢ Max tangential Blade Acceleration is 5+ G's at its Radius of Gyration

➢ Repeatable Motion **Required for Science**, Smooth Motion Desired for Jitter

　　➢ ON / OFF Drive Profile Illustrated for Comparisons Only

Candidate Smooth Shutter Motion Function

SNAP - Cassegrain Mask & Shutters

Observatory Disturbances in Pair Operation

➢ Transmitted Forces are Ideally Zero, with Small Balance Residuals in Practice

➢ Transmitted Moments cannot be Zero, but are mostly Reacted in the Stiff Mask

➢ **Single** Shutter Operation Disturbances

    ➢ Forces remain as Ideally Zero, Small in Practice

    ➢ Moment of Momentum changes Pointing by $\approx$ 14 MAS *(20 MAS is our ACS goal)*

➢ The Shock Response Spectra (SRS) is the "pre – FEM time step approach" to transients

    ➢ Predicts any 2 DOF system response at F_n Hz

    ➢ Usual format is acceleration, from test data

    ➢ Math is a Rigorous Convolution Integral

    ➢ SQ Torque (ON/OFF) for comparisons only

    ➢ **NO** $^{1}/_{R}{}^{2}$ Transmission Losses are Included !

*Note that Torques are **large** compared to Forces*

SRS of a Single Shutter Motion
(5% Static Imbalance Assumed)
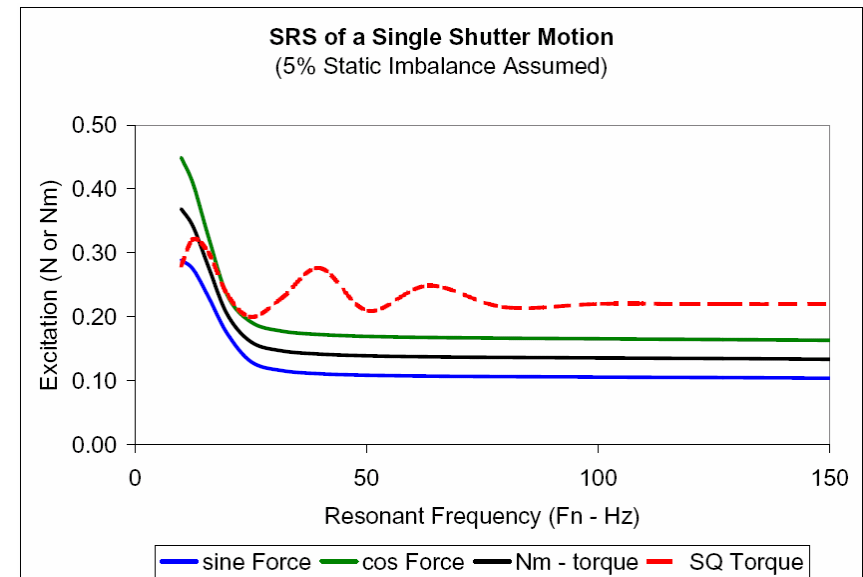
Preliminary Electrical / Functional Block Diagram